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Radially Anisotropic Shear Wave Structure of Australian Region from Multi-mode Surface Wave Tomography

Kazunori Yoshizawa[1*], B.L.N. Kennett[2]

[1]Faculty of Science, Hokkaido Univ., [2]RSES, Australian National Univ.

We developed a new three-dimensional shear wave speed model for the upper mantle beneath the Australian region from multi-mode surface waves. A large number of phase speed data from both Love and Rayleigh waves are extracted from three-component seismic records of seismic stations in the Australia and its surrounding region over the period between 1990 and 2008, using the networks reporting to IRIS, as well as portable seismic arrays deployed by the Australian National University.

We used a fully automated technique of multi-mode dispersion measurements with a nonlinear waveform fitting based on a direct model-parameter search using the Neighbourhood Algorithm. Over 6,000 paths for both Love and Rayleigh waves are collected to cover the entire Australian continent, which allow us to extract lateral heterogeneity as well as radial anisotropy with extended horizontal and vertical resolution. The path-specific phase speeds are inverted to produce multi-mode phase speed maps incorporating approximate finite-frequency effects via the surface-wave influence zone, within which surface waves can be considered to be coherent in phase. A 3-D radially anisotropic shear wave speed model is then derived from simultaneous inversions of local dispersion curves of multi-mode Love and Rayleigh waves.

The new 3-D model shows a good correlation of fast shear wave speed anomalies with regions of Archaean and Proterozoic cratons in the western and southern Australia down to a depth of about 200 km. Owing to the enhanced vertical resolution with the higher mode information, the subduction of the Australian plate in the north beneath Indonesia has also been mapped clearly. Three-dimensional distribution of radial anisotropy indicates faster SH anomaly than SV beneath the central and western Australia down to about 300 km depth, indicating possible effects of strong shear motion in the lithosphere-asthenosphere boundary beneath the continent.

Keywords: surface wave, tomography, anisotropy, continent, Australia